

P R E F A C E

This book has been prepared to assist you in determining the steam requirements of a boiler or boilers to meet the requirements of a particular application.

When steam requirements are known this book may be used to check these ratings.

Steam requirements shown on name plates of equipment shall be used instead of the steam requirements listed herein.

The information included in this book has been compiled from many sources and it is believed to be authentic, however, we would appreciate having any errors or discrepancies reported to us.

We propose to revise this book from time to time as the need arises.

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The principal requirements for steam in bakeries is for proof boxes, bake ovens, jacketed kettles, hot water for washing, and space heating. A low pressure boiler will satisfy the need of most bakeries.

(The following material concerns ovens and proof boxes. Information on jacketed kettles, hot water and heating will be found under separate headings).

PROOF BOXES are used to speed the process of raising yeast dough before baking in ovens. The proof box is similar to a steam room since steam is injected directly into the box to obtain a warm humid atmosphere. The amount of steam released is regulated in accordance with the amount of dough to be raised. The maximum steam requirement of the proof box should be used as its rating. Steam at 15#/sq. in. should be used.

Commercial types of proof boxes are rated by the number of racks they contain, on the basis of .33 BHP per rack. The standard proof rack is about 30" wide by 5'10" long, and holds 8 to 10 trays of bread. Proofing time varies from 45 to 60 minutes.

Steam requirements may also be determined on the basis of .5 BHP for 250# of baked goods per hour according to one manufacturer.

Another proof box manufacturer recommends that the minimum boiler horsepower shall be 8 BHP.

BAKING OVENS are of three types: The simple hearth oven, the traveling oven, and the revolving oven. In all types, steam is injected into the baking chamber to cure the bread or to glaze the surfaces of certain breads and rolls. The normal baking time for bread is 30 minutes, so that bakeries usually average two bakes per hour. Our experience has shown that oven manufacturers are inclined to under estimate the steam required for their ovens. A common practice has been to rate ovens on the basis of 1 BHP per 100# of bread baked per hour. Thus, if an oven had a bread capacity of 100# of bread, then with two bakes per hour (200#/hr.) the oven would consume 2 BHP. This figure is actually far too small; we recommend using 2 BHP per 100# of bread baked per hour.

HEARTH TYPE OVENS - Bakers are usually familiar with the bread capacity of these ovens. In cases where the oven identification is missing, the capacity must be computed. Having determined the baking surface in the oven, the bread capacity can be determined by the number of trays or bun pans the oven will hold. The following data will be useful.

Trays 20", 23" and 26" widths,
 7", 8" and 9" lengths

Standard Bun Pan 18" x 26"

1# Loaf 11" long
1½# Loaf 13" long

REVOLVING OVENS may contain from 4 to 12 trays which revolve on a wheel somewhat like a ferris wheel. These ovens are rated according to the number and size of trays they contain. The Middleby-Marshall Oven Co., gives the following data.

Size No.	No. of Trays	Tray Size	C A P A C I T Y		
			18" x 26" Bun Pans	1 lb. Loaves	BHP
750	4	20 x 54	8	80	3.2
751	4	20 x 80	12	128	5.1
752	6	20 x 54	12	120	4.8
754	6	20 x 80	18	192	7.7
760	6	23 x 92		216	8.7
761	6	23 x 110		264	10.6
762	6	23 x 128	These sizes especially designed for maximum bread capacity	288	11.5
763	6	23 x 146		352	13.5
764	8	23 x 92		304	11.5
765	8	23 x 110		352	14.1
766	8	23 x 128		384	15.4
767	8	23 x 146		448	17.9
768	10	23 x 110		440	17.6
769	10	23 x 128		480	19.2
770	10	23 x 146		560	22.4
771	12	23 x 128		576	23.1
772	12	23 x 146		672	26.9
719	6	26 x 60	18	150	6.0
723	6	26 x 78	24	210	8.4
724	6	26 x 96	30	240	9.6
725	6	26 x 115	36	330	13.2
726	8	26 x 96	40	320	12.8
728	8	26 x 134	56	480	19.2
730	10	26 x 134	70	600	24.0

TRAVELING OVENS - The trays in this type of oven are in motion continuously. A man loads constantly and the bread is discharged automatically. These ovens are described as "tunnel" ovens when the bread is loaded at one end and unloaded at the other end. Tunnel ovens vary in length from 80' to 110'. The Peterson Oven Company of Chicago furnishes the following data:

C A P A C I T Y

<u>No. of Trays</u>	<u>Tray Size</u>	<u>18" x 26" Bun Pans</u>	<u>1 Lb. Loaves</u>	<u>BHP</u>
10	23½ x 96	30	320	12.8
10	23½ x 108	40	360	14.4
10	26 x 98	50	320	12.8
10	26 x 110	60	400	16.0
12	23½ x 96	36	384	15.4
12	23½ x 108	48	432	17.3
12	23½ x 120	48	480	19.2
12	26 x 98	60	384	15.4
12	26 x 110	72	480	19.2
15	23½ x 108	60	540	21.6
15	26 x 110	90	600	24.0
16	23½ x 120	64	640	25.6
16	26 x 110	96	576	23.1
18	23½ x 108	72	648	26.0
18	26 x 110	108	648	26.0
20	23½ x 120	80	800	32.0
22	23½ x 120	88	880	35.2

B A T H S (Steam)

Turkish bath houses require 5 to 10# steam pressure. The usual inside temperature is 110°F. Allow one boiler horsepower per 100 square feet of steam radiation. This rating includes compensation for all losses.

B A T T E R I E S

Steam is required in battery manufacturing for melting wax compounds. Steam jacketed kettles are used for this operation. When the compounds to be melted have a melting point below 337°F., a 100 PSI boiler can be used. Boilers designed for higher pressure are necessary for higher temperatures. To compute the steam requirements, make use of the data given under Process Heating.

B O T T L I N G
(Soft Drinks)

Steam is used in bottling plants for washing bottles, cooking syrups, pasteurizing certain fruit and milk beverages, space heating, and making hot water for sanitation.

Uncarbonated beverages are usually pasteurized and the pasteurizing is done after the beverages are bottled.

Estimate carefully the amount of water used for wash down since its liberal use may require additional boiler capacity.

BOTTLE WASHERS (Soaker Type) - The size of a washer is measured in terms of the number of bottles it will hold crosswise (6 wide, 8 wide, etc.); the capacity of the washer (bottles per minute); and the number of compartments. A washer may have from 1 to 6 compartments. These compartments are actually tanks. In a 4 compartment washer, the first tank holds hot water for soaking, the second washing solution, the third rinse, and the fourth hot water. The greatest load occurs in bringing the tanks up to temperature from a cold start.

Horsepower ratings for several types of washers are tabulated on the adjoining pages and ratings for most soaker type washers can be estimated from the tables for the types furnished here. For types not listed on the following tables, use 10 BHP per 100 bottles washed per minute.

It should be realized that ratings are based on assumptions regarding the time allowed for heating up the solutions, the temperature of the water supply, and recovery of condensate. Some washers are designed for high pressure steam, others for low pressure steam. These matters should be investigated and allowances made when calculating the boiler capacity required.

Michael Yundt Company
"Air Brush" Type Bottle Washer

<u>Size</u>	<u>No. of Compartments</u>	<u>B.P.M.* Capacity</u>	<u>BHP $\frac{1}{2}$ Pints</u>	<u>BHP Pints</u>	<u>BHP Quarts</u>
6 Wide	3		4.3	3.2	4.1
8 Wide	3	50	4.3	4.6	5.3
	4	69	5.9	6.5	7.5
	5	89	7.4	-	9.8

*Bottles per Minute

"Air Brush" Type Bottle Washer (cont.)

<u>Size</u>	<u>No. of Compartment's</u>	<u>B.P.M.* Capacity</u>	<u>BHP ½ Pints</u>	<u>BHP Pints</u>	<u>BHP Quarts</u>
12 Wide	3	76	6.1	6.8	7.7
	4	100	7.8	8.4	11.0
	5	133	10.2	11.0	14.4
	6	144	11.4	13.8	17.8
16 Wide	4	140	10.5	11.1	14.5
	5	178	13.2	14.6	19.0
	6	191	14.2	18.5	23.6
20 Wide	4	174	12.6	13.7	18.0
	5	222	15.9	18.2	23.7
	6	240	17.2	23.0	29.3
24 Wide	5	267	19.2		
	6	325	23.4		

The Heil Company
"Nu-Way" Bottle Washer

<u>Model</u>	<u>Size</u>	<u>Capacity B.P.M.*</u>	<u>BHP**</u>
KHQ	4 Wide	32 Quarts	8
	6	48	10
	8	64	15
	12	96	18
KH2Q	4	24 Half Gallons	9
	6	36	12
	8	48	15

* Bottles Per Minute

** Boiler Horsepower required to heat water to operating temperature from 60°F. in 2 hours, with minimum steam pressure of 15 PSI.

HORSEPOWER RATING - TWO TYPES OF BOTTLE WASHERS

<u>Size</u> <u>(Wide)</u>	<u>No.</u> <u>Compts.</u>	<u>B.P.M.</u>	<u>1/2</u> <u>Pt.</u>	<u>Pint</u>	<u>Qt.</u>	<u>B.P.M.</u>	<u>1/2</u> <u>Pt.</u>	<u>Pint</u>	<u>Qt.</u>
5	3							7.0	
8	3	60	5.5	6.0	7.5	80	7.0	8.0	11.0
	4	80	6.9	7.9	9.7	80	8.0	9.0	12.0
	5	80-100	7.8	9.9	12.3	80	10.0	10.0	14.0
	6						11.0	11.0	15.0
12	3	90-120	9.5	10.1	12.6	120	8.0	12.0	17.0
	4	120-140	11.3	11.8	13.0	120	10.0	13.0	18.0
	5	120-140	11.9	13.9	17.4	120	12.0	14.0	19.0
	6	120-140	12.5	13.9	17.4	120	15.0	15.0	21.0
16	3	140	11.9	13.9		160	13.0	15.0	21.0
	4	160	13.9	16.0	19.4	160	14.0	16.0	22.0
	5	160-180	14.8	17.4	20.7	160	17.0	18.0	25.0
	6	160-180	15.7	17.9	21.6	160	20.0	20.0	28.0
20	4	200	17.3	18.4	23.0	200	17.0	18.0	25.0
	5	200-240	19.0	18.9	24.3	200	20.0	21.0	30.0
	6	200-240	20.8	19.0	24.3	200	25.0	25.0	35.0
24	5	240	20.8	21.8	31.3	240	24.0	25.0	
	6	240-280	22.6	23.7	31.3	240	30.0	30.0	

DUMORE JUNIORS

4	1	24-30		2.0	2.5
	2	30		2.9	3.6
	3	40		4.2	5.2
8	1	48-50		4.7	5.8
	2	60		6.0	7.5
	3	80		7.9	9.7
12	1	72-90			8.7
	2	90		8.7	11.0
	3	120		11.7	14.2
16	3	160		15.7	18.2

PASTEURIZERS (Soft Drink) - Certain beverages, such as chocolate milk and uncarbonated fruit drinks, must be pasteurized after bottling. The Michael Yundt Company furnishes the following ratings for their pasteurizing equipment:

<u>Basket Type</u>	<u>Automatic Type</u>	<u>BHP</u>
Model 135	Model 5	4.2
128	7½	6.3
168	10	8.4
208	12½	10.6
219	15	13.6
289	20	16.8
359	25	21.0
429	30	25.2
569	40	33.6

STERILIZERS - The following ratings are furnished by the Fort Wayne Dairy Equipment Company

<u>Half-Pint Bottles</u>		
<u>Model</u>	<u>Steam</u>	<u>Steam & Water</u>
Junior	8 BHP	15 BHP
#22A	15	30
#36A	20	40
#45	25	55
#54	35	70
#72	40	80
#96	45	100

BROOMS AND BRUSHES

High pressure steam is used for processing broom corn and for vulcanizing rubber set brushes. Find the specific heat of the materials used in the process and the amount of the temperature rise, With this information the number of BTU's required for operation can be calculated. Divide the total BTU/hr by 33,500 to obtain boiler horsepower.

C A N D Y

Candy manufacturers require a steam for melting chocolate in jacketed kettles and for making hard candies in vacuum pans. High pressure steam is required for making hard candies. (Refer to Jacketed Kettles).

A 250# capacity vacuum candy pan made by Savage Bros. requires steam at 90 PSI and is rated at 8.5 horsepower.

Candy and Chocolate	#Steam	
Candy cooking, 30 gal. cooker	Per Hr.	
1 hr. 325°	Per Unit	BHP
	46.9	1.6.
Chocolate melting, jacketed,		
24" dia.	29.3	1.0
Chocolate dip kettles, per 10 sq.		
ft. tank surface	29.3	1.0
Chocolate tempering, tops mixing,		
ea. 20 sq.ft. active	29.3	1.0
surface		

C A N N I N G

Canning retorts and cookers usually require steam at 15 PSI in order to obtain desired temperatures. It is often advisable to install a high pressure boiler and reduce pressure with pressure-regulating valves to obtain dry, low pressure steam.

BLANCHERS - The following ratings apply to spinach blanchers made by the Food Machinery Corporation, (Sprague Sells Div.)

Model #5756 Hot Water Tank 20' x 5½' x 4½'	15 BHP
#5757 Hot Water Tank 20' x 6½' x 4½'	20 BHP

FRUIT JUICE PASTEURIZERS (Food Machinery Corp., Sprague Sells Division)

Model #4500-1-2-3	30 Gal./Minute	35 BHP
	40 Gal./Minute	45 BHP

PREHEATERS (Food Machinery Corp., Sprague Sells Div.)

Model #2060 Crusher Preheater for		
tomatoes, citrus		25 BHP
Duplex Mixer-Preheater for corn, meat, etc.		
rating per 600 No. 1 cans/hr.		1 BHP

Canning (Cont.)

RETORTS

Food Machinery Corp. 42" x 72"	10 BHP
A K. Robbins Company 42" x 104"	5 BHP

SCALDER (Food Machinery Corp., Sprague Sells Div.)

Draper Type Peeling Scalders	
#5005-6-7, tank 6' x 12'	20-25 BHP
Kyle Type for Scalding before peeling	
#8670-74, tank 6'-15' x 4' wide	15-20 BHP
Tomato Scalders - 16' long x 2½' wide	7 BHP

STEAMER (Food Machinery Corp., Sprague Sells Div.)

Continuous high pressure steamers with feed elevator for potatoes, beets, carrots, etc. #8689	30 BHP
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C H E M I C A L S

Steam is required in the chemical process industries for jacketed kettles, autoclaves, stills, sterilizers, retorts, vacuum pans, etc. The steam demand equipment is so specialized that a detailed list is impracticable. However, steam requirements can often be figured by use of computations as outlined under Jacketed Kettles.

C O N C R E T E B L O C K S

The selection of a boiler for a live steam curing system is of prime importance. The size of the boiler selected depends upon the load requirements of the kiln and the number of kilns to be steamed simultaneously.

Feed water is assumed to be at 50°F in the following calculation for boiler capacity required:

for blocks 8" x 16" use 15 BTU/block

$$\text{B.H.P.} = \frac{15 \times \text{No. Kilns} \times \text{blocks/kiln} \times \text{temp rise/hr.}}{33,475 \times 0.86}$$

A good average temperature rise/hr = 60°F.
 Correction factor for 50°F. Feed water = 0.86

The above formula results in 0.03125 BHP required per block under average conditions.

The following tabulation may be of value:

<u>Kiln Capacity 8" Unit</u>	<u>BHP for 1 Kiln</u>	<u>BHP for 2 Kilns Simult.</u>	<u>BHP for 3 Kilns Simult.</u>
864	30	60	90
1080	35	70	105
1200	40	80	120
1440	45	90	135
1728	55	110	165
2160	70	140	210

The above figures are considered to be too conservative by some, but in no case would we recommend sizing the boiler smaller than on the basis of 0.02 BHP/block.

D A I R I E S

MILK PRODUCTION - The usual independent dairy, or dairy farm, is concerned with producing and selling raw milk. Although some of these convert milk to butter, cheese, and ice cream, this type of operation is carried on usually by the large cooperatives and large producers. The principal steam requirement is for pasteurizing milk, washing bottles, washing cans, heating, and making hot water for sanitary purposes.

BOTTLE WASHERS - There are 2 types of washers. In one type the bottles are washed without removing them from the cases. Those washers are used by small producers and they are operated manually. Ratings for a representative type are listed below:

Dostal and Lowey (6wide) Quart bottles

<u>Cases/Hr.</u>	<u>BHP</u>
75	8
90	10
120	12
150	13
180	14

Dairies (cont.)

The automatic type of washer with soaker is more widely used by dairies. Sizes are determined by the number of bottles that can be fed cross wise (4 wide, 6 wide, etc.). Ratings furnished by several manufacturers of this equipment are listed below:

Cherry-Burrell Corp.

Soaker Type Washer Model E 960-65# SWP

4 wide	6 BHP
6	9
8	12
10	15
12	18

Creamery Package Mfg. Co.

<u>Model</u>	<u>Size</u>	<u>BHP</u>
Bantam	6 wide	2
Junior	4	4
	6	6
	8	8
Type C	8	12
	10	14
	12	16

Rotary

General Dairy Equipment Co. - use same ratings as for Cherry-Burrell Washers of identical size.

R. G. Wright Co., Inc.

<u>Model</u>	<u>Size (Wide)</u>	<u>B.P.M. Capac't</u>	<u>BHP</u>
Triten	4	24	4
Triten	6	36	6
Senier	6	48	7

Heil Company "Nu-Way"

<u>Model</u>	<u>Size (Wide)</u>	<u>B.P.M. Capac't</u>	<u>BHP*</u>
KHQ	4	32	8
(Qt.	6	48	10
bottle)	8	64	15
	12	96	18

* BHP required to heat 60°F. water to operating temperature in 2 hrs. at 15 PSI steam pressure.

CAN WASHERS (C.P.M. - Cans Per Minute)

Creamery Package Company

<u>Model</u>	<u>C.P.M. Capacity</u>	<u>BHP</u>
Rotary #2	3	10
Rotary #1	6	15
Washmaster	6	20
"	8	25
"	10	30
"	12	35
"	14	40

Lathrop Paulsen Company

<u>C.P.M. Capacity</u>	<u>BHP</u>
3	9
6	14
8	16
13	21
14	23
14	25
("Microsan" or "Conservation")	

Dairies (cont.)

General Dairy Equipment Company - use same ratings per size as for Creamery Package Co.

<u>Damrow Bros. Co.</u>			<u>Damrow Bros. Co.</u>		
<u>Straight-away Model</u>	<u>C.P.M. Capac.</u>	<u>BHP</u>	<u>Rotary Model</u>	<u>C.P.M. Capac.</u>	<u>BHP</u>
S4	4	7	R	2½	8
S5	5	8	J	4	9
S6	6	10	K	4	10
S9	19	18	H	3-6	12
S12	12	20	L	6	12
S14	14	25			

<u>Oakes & Burger Co.</u>			<u>R. G. Wright Co., Inc.</u>		
<u>Model</u>	<u>C.P.M. Capac.</u>	<u>BHP</u>	<u>Model</u>	<u>C.P.M. Capac.</u>	<u>BHP</u>
Rotary	2½	6.5	Rotary CD	3	10
	4	8.0		4	12
	6	10.0	Str'away	6-7	20
Super-duty	4	10.0		8-10	30
	6	12.0		12-14	36
	9	17.5	Barnum	3-4	5
	12	22.5			

<u>Stoelting Bros. Co.</u>		
<u>Model</u>	<u>C.P.M. Capac.</u>	<u>BHP</u>
Str't-away (Type R)	2½	5
	4	8
	6	12

PASTEURIZERS - Conventional pasteurization consists of raising milk temperature to 145°F. and maintaining the temperature for approximately 30 minutes.

The "short time" pasteurizer (described in a later paragraph) uses a higher temperature and a shorter time interval.

Pasteurization tanks are heated either by steam jackets, or by water jackets into which steam is injected. In the latter case, there is no condensate returned to the boiler.

Pasteurizers (cont.)

The maximum steam load depends upon the speed with which the milk is raised to pasteurization temperature and the temperature of the incoming milk. Milk shipped from outside points must be chilled for shipment. When milk begins arriving at the dairy, there is pressure to pasteurize at maximum capacity since milk cans must be emptied, washed, and returned to the truckers. Facilities for storing bulk milk are usually limited so that milk is pasteurized as rapidly as possible and moved along to the bottling operation.

The following ratings for pasteurizers can be used for the typical dairy:

<u>Size</u> <u>(Gals.)</u>	<u>Heating</u> <u>Period</u>	<u>HP</u>
50	15 min.	4.8
100	20	7.5
150	20	11.0
200	20	14.5
300	20	21.0
400	30	22.0
500	30	27.5
1000	30	55.0

The "short time" pasteurizer makes use of a regeneration cycle to reduce pasteurization time and lower steam consumption. Milk is heated to 165°F. and held at that temperature for 16 seconds. The hot milk leaving the pasteurizer passes through a heat exchanger to transfer part of its heat to the incoming milk. The rating for pasteurizers of this type is:

1.5 BHP per 1000# of milk/hr.

MILK PRODUCTS

DRIED MILK - Raw milk contains approximately 12.2% solids. About 819# of raw milk are required to produce 100# of dry powdered milk. Ratings for equipment used in drying milk are listed below (100 psi working pressure boiler is required).

Milk Products (cont.)

Douthitt Gray-Jensen Co.

Spray Process Drying Plant

<u>Model</u>	<u>Capacity</u>	<u>BHP</u>
18	700# milk	241
14	450	160
10	200	64

Overton Machine Company

American Milk Drier

<u>Model</u>	<u>Size</u>	<u>BHP</u>
42A	42" x 120"	125
AAA	36" x 120"	108
A	35" x 84"	64
B	28" x 72"	42
C	24" x 60"	29

C. E. Rogers Company

Spray Driers

200#/hr.	35 GHP	700#/hr.	130 BHP
350	65	900	175
500	95	1100	210

CONDENSED (EVAPORATED) MILK is produced by evaporating part of the moisture from whole or skim milk. The boiler horsepower required depends upon the type and quantity of produce. Condensed milk is manufactured in ratios of 1:5 to 1:2 of raw milk. The evaporating or condensing takes place in vacuum pans, which are operated under approximately 210°F. before entering the vacuum pan.

The following ratings are computed from data furnished by the Mojonier Bros. Co. The boiler horsepower (BHP) indicated for the various sizes includes preheating the raw milk from room temperature to 210°F

<u>Diameter of Vacuum Pan</u>	<u>2:1 Cond. Whole or Skim Milk</u>		<u>3:1 Cond. Whole or Skim Milk</u>	
	<u>Capacity*</u>	<u>BHP</u>	<u>Capacity*</u>	<u>BHP</u>
16"	165	6.0	69	5.0
26"	450	17.0	188	13.5
36"	1050	39.5	438	31.0
42"	1980	71.0	825	59.0
48"	3330	124.5	1388	98.0
60"	4590	171.5	1913	135.0
72"	7830	292.5	3263	230.0

Condensed Milk (cont.)

<u>Diameter of Vacuum Pan</u>	<u>4:1 Condensed Skim Milk</u>		<u>5:1 Condensed Skim Milk</u>	
	<u>Capacity*</u>	<u>BHP</u>	<u>Capacity*</u>	<u>BHP</u>
16"	37	3.8	21	3.0
26"	100	10.5	56	7.5
36"	233	24.0	131	17.5
42"	440	45.5	248	34.0
48"	740	76.5	416	57.0
60"	1020	105.0	574	78.5
72"	1740	180.5	979	134.0

	<u>3.55: Sweetened Cond. Whole Milk</u>		<u>2 75:1 Sweetened Cond. Skim Milk</u>	
	<u>Capacity</u>	<u>BHP</u>	<u>Capacity*</u>	<u>BHP</u>
16"	48	4.2	85	5.5
26"	129	11.5	231	14.5
36"	302	27.0	540	33.5
42"	569	50.5	1018	63.4
48"	958	85.0	1713	106.5
60"	1320	117.0	2361	147.0
72"	2252	200.0	4027	250.5

*Capacity is the output of
condensed milk in lbs/hr.

Fort Wayne Dairy Equipment Co.
Sterilizer for Evaporated Milk Cans

<u>Capacity (C.P.M.)</u>			<u>Boiler Horsepower</u>	
<u>Baby</u>	<u>Tall</u>	<u>Gal.</u>	<u>Steam</u>	<u>Steam & Water</u>
96	40	24	18	36
144	58	36	20	40
180	73	45	25	50
216	88	54	35	70
288	117	72	40	80
384	155	96	50	100
480	195	120	60	120

Milk Products (cont.)

CHEESE VATS - The Damrow Bros. Company furnishes the following ratings for their jacketed cheese vats. A boiler with design pressure of 100 PSI is recommended. The usual temperature rise is 60°F. to 105°F.

<u>Model</u>	<u>Capacity</u>	<u>BHP</u>
2	1,500 lbs.	3.2
12A	4,000	6.3
16DD	7,500	12.0
20E	9,300	14.5
24FFF	14,000	21.0

D R Y C L E A N I N G

Dry cleaning operations requiring steam can be divided roughly into (1) spotting, (2) drying or deodorizing, (3) distilling solvent (cleaning fluid), and (4) finishing garments.

DRY CLEANING MACHINES do not require steam except in the case of combination units which include a tumbler and a still. Ratings for some combination units are as follows:

Prosperity Company Model 6-A	9 BHP
Model 3-B	10 BHP
American Laundry Mach'y Co., "Noex"	5 BHP
Shields Model R-50 (Synthetic Solvent)	4 BHP

Ratings for other types (not listed here) can be determined from the capacities of their tumblers and stills.

SPOTTING is the process of removing spots which are not removed by the usual cleaning solvent. In some cases this involves pre-spotting to supplement the action of the solvent. The principal items of equipment used for this purpose are the steam gun and the spotting board.

Steam finishing board (steam vacuum)	2 BHP
Wool spotting table	1 BHP
Steam Gun	.75 BHP

Dry Cleaning (cont.)

DRYING OR DEODORIZING takes place after the garments leave the cleaning machine. Most of the excess solvent is removed by the extractor which spins at high speed and releases solvent from the garments by centrifugal force. The remainder of the solvent is removed by subjecting the garments to warm air circulation. Three types of equipment are used: tumblers, deodorizing cabinets, and the windwhip.

The tumbler consist of a wheel with perforated outer wall mounted inside a cabinet. Garments are placed inside the wheel which is rotated to tumble them, while warm air circulates through the cabin to carry away excess solvent and odors. The size of a tumbler is determined by the diameter and depth of the wheel. The temperature range is from about 115°F. to 140°F. depending on the type of fabric to be tumbled.

Huebsch Steam Heated Open End Tumblers

<u>Size</u>	<u>1 Coil</u>	<u>2 Coil</u>	<u>4 Coil</u>
36" x 18"	2.05 HP	2.65 HP	3.20 HP
36" x 24"	2.29	2.79	3.73
36" x 30"	2.52	3.20	3.90

Note: Coils are located at top of cabinet with space for two on each side.

U. S. Hoffman Machine Co. "Vorclons"

<u>Size</u>	<u>BHP</u>
32" x 40"	5
42" x 40"	6
42" x 60"	8
42" x 90"	12
42" x 120"	16
46" x 120"	18

American Laundry Machine Co. "Zone Air"

<u>Size</u>	<u>BHP</u>
36" x 18"	2.5
36" x 24"	3.0
36" x 30"	3.5
36" x 42"	5.0
36" x 48"	6.0

Deodorizing cabinets are ventilated chambers equipped with heating coils. The U.S. Hoffman Machinery Corporation gives these ratings for two types of cabinets:

40" square cabinet	1.5 BHP
38" round cabinet	1.0 BHP

Dry Cleaning (cont.)

The windwhip is a small air heater over which garments are suspended. The best application is for light fabric (such as silks) which must be dried separately and quickly.

These units are rated at 2.0 BHP for single units
3.0 BHP for double units

STILLS - Cleaning solvents are used over and over and require the use of filters and stills to purify the solvent after each cleaning cycle. The following ratings are for distilling petroleum solvents:

U. S. Hoffman Machinery Corporation Fill-Pro Vacuum Stills

<u>Size</u>	<u>H.P.</u>	<u>Size</u>	<u>H.P.</u>
25 Gal.	1.5	125-150 Gal.	5.0
50	2.0	175-200	6.0
75	3.0	250	9.0
100	4.0	350-400	14.0

FINISHING EQUIPMENT consists of presses, Suzie-Q, puff irons, trouser stretchers, etc. The ratings of the larger presses are based on the use of air vacuum.

Garment Pressed

<u>Size</u>	<u>H.P.</u>	<u>Size</u>	<u>H.P.</u>
25"	.3	51"	1.2
38"	.7	52"	1.5
40"	1.0	54"	1.9
45"	1.2		

The Suzie-Q consists of a manikin mounted on a steel base with steam and air connections. The garments are placed on the manikin and inflated with steam while they are shaped and the wrinkles are brushed out with a whiskbroom. Ratings for this equipment vary from 1.5 BHP for women's garments to 2.0 BHP for men's coats.

Trouser stretcher	1.25 BHP
Puff irons (per set)	.50 BHP
Steam iron (hand finishing)	.16 BHP

D Y E I N G

The process of dyeing consists of dipping fabrics in a dye solution (called liquor) at boiling temperature, rinsing and drying. In the ordinary dye vat, steam jets are located in the bottom of the vat, or tank, to heat the liquor to boiling temperature. The turbulence from the steam jets agitates the liquor and mixes the solution thoroughly.

The following formula provides a practical method of computing the boiler horsepower required for a dye vat:

$$\text{BHP} = \frac{C \times 8.33 \times (210-T)}{33,500}$$

BHP - Boiler horsepower/hr.
C - Capacity of vat in Gal.
T - Temp. of water supply

For example: Assume a vat of 400 gal. capacity, and water supply temperature of 60°F.

$$\text{BHP} = \frac{400 \times 8.33 \times (210-60)}{33,500} = 14.9$$

This formula is based on raising the temperature of the liquor to boiling in 1 hour. If the vat is brought to temperature in 30 minutes, multiply the result by 2; if 20 minutes, multiply by 3; and if 15 minutes, multiply by 4.

Many dye plants have installed storage tanks to maintain a supply of pre-heated water at about 150°F. temperature. In this way the drain on the boiler due to short peak loads is reduced, and the steam requirement should be modified accordingly.

PACKAGED DYE MACHINES - Smith, Drum & Co., Philadelphia, Pa., offer the following ratings for various models of their package dye machine. These figures are based on raising the liquor from 50°F to 200°F in 15 minutes, with steam at 100 PSI.

<u>Model Dye Machine</u>	<u>BHP</u>	<u>Time(Min.)</u>
500# Package	60	20
200#	48	20
100#	24	20
Single Tube Skein	1.5	15
Three Tube Skein	3.0	15
Seven Tube Skein	4.5	15
Twelve Tube Skein	12.0	15

Dyeing (cont.)

DRYING - After the cloth has been dyed, it must be dried. This may be done in a heated compartment or cabinet. The load can be determined from the size of the heaters, pipe coils, or other heating element provided. Smith, Drum & Co. manufacture a package drying machine which is rated at 19 BHP.

HOSPITAL EQUIPMENT*

HOSPITAL POWER PLANT - Nervous and mental hospitals and other institutions where requirements are moderate, need approximately .7 boiler horsepower per bed. In general acute disease hospitals this requirement is estimated at a peak of 2 boiler horsepower per bed. In order to have steam and hot water always available, the public health service recommends 3 boilers of 40% of peak demand capacity each or 2 boilers of 66% of peak demand capacity. Because of the requirements for high pressure steam for sterilizers it is recommended that boilers be capable of a working pressure of 125 pounds.

The general acute disease hospital requires approximately 8.5 gallons of hot water at 180° per bed per hour--4.5 gallons for laundry and 4 gallons for dietary. In addition, 6.5 gallons at 120° per bed per hour are needed for the other hospital requirements. Laundry requirements are predicated on a load of 12 to 20 pounds per patient day.

	<u>Lbs.Steam/Hr.</u> <u>Per Unit</u>	<u>BHP</u>
Stillls, per 100 gal. distilled water	102.6	3.5
Sterilizers, bed pan	2.9	0.1
Sterilizers, dressing, per 10" length, approx.	7.1	0.25
Sterilizers instrument, per 100 c. in approx.		
Sterilizers water, per 10 gal. water, approx.	5.8	0.2
Disinfecting ovens, double door:		
up to 50 cu.ft. per 10 cu.ft. appr.	29.3	1.0
50 to 100 cu.ft. per 10 cu.ft. appr.	21.6	0.8
100 and up, per 10 cu.ft. appr.	16.0	0.6

*Reprinted from The Modern Hospital Fact Book 1958

H O T W A T E R

ESTIMATING HOT WATER CONSUMPTION - The consumption of hot water in many industries can be computed from the capacities of hot water used by production equipment. The use of hot water for sanitary purposes presents a more difficult problem.

The following tables will help to estimate the hot water requirements of apartment houses, hotels, hospitals, office buildings, etc. A summary of the hot water demand of all fixtures contributing to the load gives the total connected load.

The "Hourly Heating Capacity Factor" will give the percent of the total connected load which the boiler must be capable of heating. The "Storage Capacity Factor" indicates the size of storage tank that should be furnished to handle the hot water load economically.

Care must be exercised in the calculation of average hot water consumption. Although 400 gal. of hot water may be consumed per hour, on the average, the actual use may be 300 gal. in the first 30 minutes, and 100 gal. in the last 30 minutes. In such case, the maximum load would be a rate of 300 gal. per 30 minutes, or 600 gal. per hour. A hot water storage tank should be used to level out short peak loads.

See pages 22, 23 and 24

**HOT WATER DEMAND PER FIXTURE
VARIOUS TYPES OF BUILDINGS**

Gallons of water per hour per fixture
calculated at a final temperature of 140°F.

	House	Club	Gym	Hosp- ital	Hotel	Indus. Plant	Office Bldg.	School
Basins, Private Lavatory	2	2	2	2	2	2	2	2
Basins, Public Lavatory	4	6	8	6	8	12	6	15
Bathtubs	20	20	30	20	20	30		
Dish- washers	15	50- 150		50- 150	50- 200	20- 100		20- 100
Foot Basins	3	3	12	3	3	12		3
Kitchen Sinks	10	20		20	20	20		10
Laundry Stationary Tubs	20	28		28	28			
Pantry Sinks	5	10		10	10			10
Showers	75	150	225	75	75	225		225
Slop Sinks	20	20		20	30	20	15	20
DEMAND FACTOR	0.30	0.30	0.40	0.25	0.25	0.40	0.40	0.40
STORAGE CAPACITY FACTOR	1.25	0.90	1.00	0.60	0.80	1.00	2.00	1.00

Courtesy of The American Society of Heating & Air Conditioning
Engineers, 62 Worth Street, New York 13, New York

Hot Water (cont.)

EXAMPLE:

Assume an apartment building:

60 Lavatories	x 2 =	120 gal/hr.
30 Bathtubs	x 20 =	600
30 Showers	x 75 =	2250
60 Kitchen Sinks	x 10 =	600
15 Laundry Tubs	x 20 =	<u>300</u>

Possible maximum demand	=	3870 gal/hr.
Probable max. demand - 3870×0.30	=	1161
Heating capacity	=	1161
Storage tank capacity - 1161×1.25	=	1450 Gal.

When the hot water requirements must be estimated for the number of people to be served, the following chart may be used:

Type of Building	Hot Water Required	Duration of Peak Load Hrs.	Max.Hrly Demand in Relation to Day's Use	Storage Capacity	Heating Capacity
Residence Apartm'ts Hotels, etc.	40*	4	1/7	1/5	1/7
Office Bldgs.	2*	2	1/5	1/5	1/6
Factory Bldgs.	5*	1	1/3	2/5	1/8
Restau- rants				1/10	1/10
Restau- rants 3 meals/da		8	1/10	1/5	1/10
Restau- rants 1 meal/da		2	1/5	2/5	1/6

*Gal/day/person

EXAMPLE:

Assume an apartment building housing 200 people	
Daily hot water req.	$40 \times 200 = 8000$ gal.
Max. hourly demand	$8000 \times 1/7 = 1140$ gal.
Duration of peak load	4 hrs.
Heating capacity	$8000 \times 1/7 = 1140$ gal.
Storage tank capacity	$8000 \times 1/5 = 1600$ gal.

Courtesy of The American Society of Heating & Air Conditioning Engineers, 62 Worth St., New York 13, New York

J A C K E T E D K E T T L E S

The jacketed kettle is a metal heating vessel surrounded by a jacket or chamber. Steam is introduced into the jacket by means of steam coils, or by injection into water (or other heat transfer medium) contained in the spaces of the jacket.

The jacketed kettle permits closer temperature control and more uniform diffusion of heat than is usually possible by direct firing. These kettles are used very extensively in the food processing industries.

The method of calculating the steam required to supply heat to a jacketed kettle depends on the nature of the substance to be heated. When the substance is water, or liquid of similar specific heat, use boiler sizing chart Fig. A. To maintain water or liquids of similar specific heat at various temperatures, refer to Fig. B.

The method prescribed under "Process Heating" applies to most other substances.

Since most jacketed kettles are not insulated, allowance must be made for the radiation of heat from the outer surfaces of the kettle. The total exposed surface should be determined and multiplied by the heat loss factor for the metal of which the jacket is constructed. If this information is not available add 37% for average losses to determine the total steam demand.

Fig. A Boiler sizing chart for steam jacketed kettles. Solution assumed to have same specific heat as water with installation at sea level.

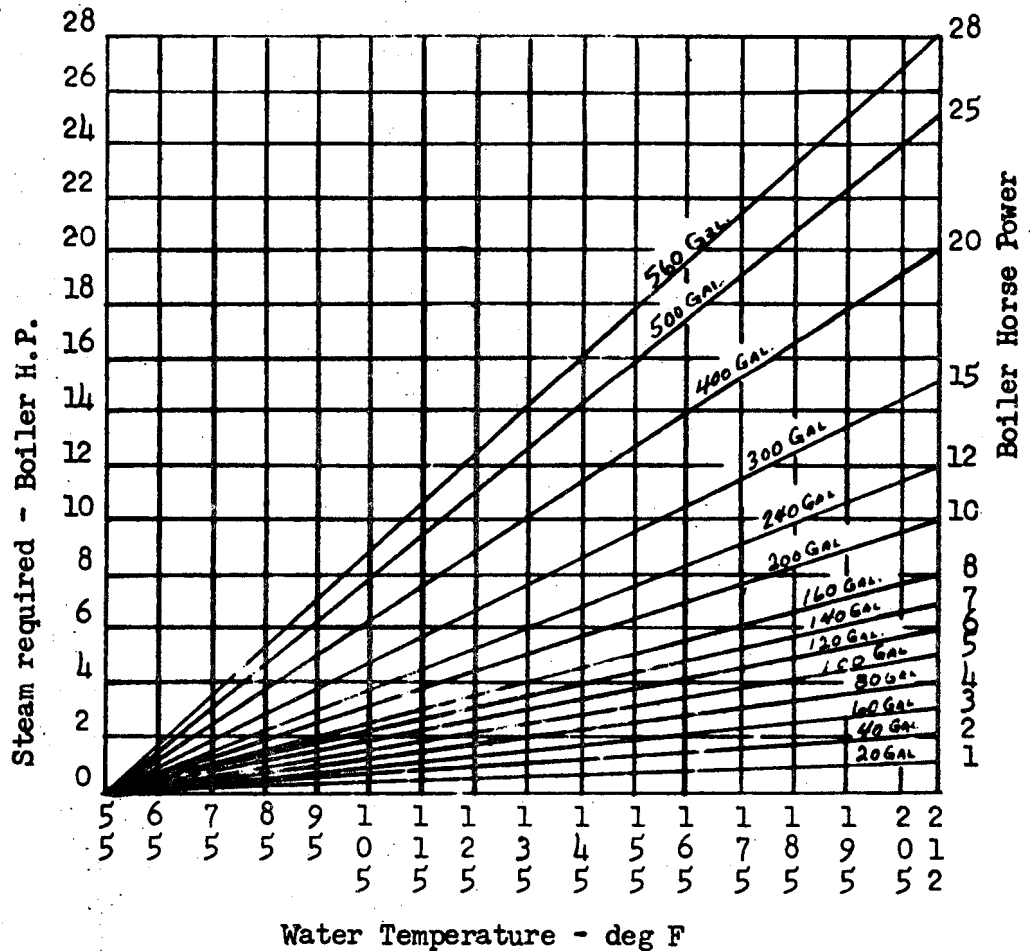


Fig. A. is based on a heating time of 1 hr. from 55°F water. When the heating time is different than 1 hr. apply the factor from Fig. C. For solutions with specific heats different than water, multiply the Boiler HP obtained from Fig. A. by the specific heat of the solution.

Fig. B Suggested boiler sizes to maintain various tank capacities at indicated temperature at sea level.

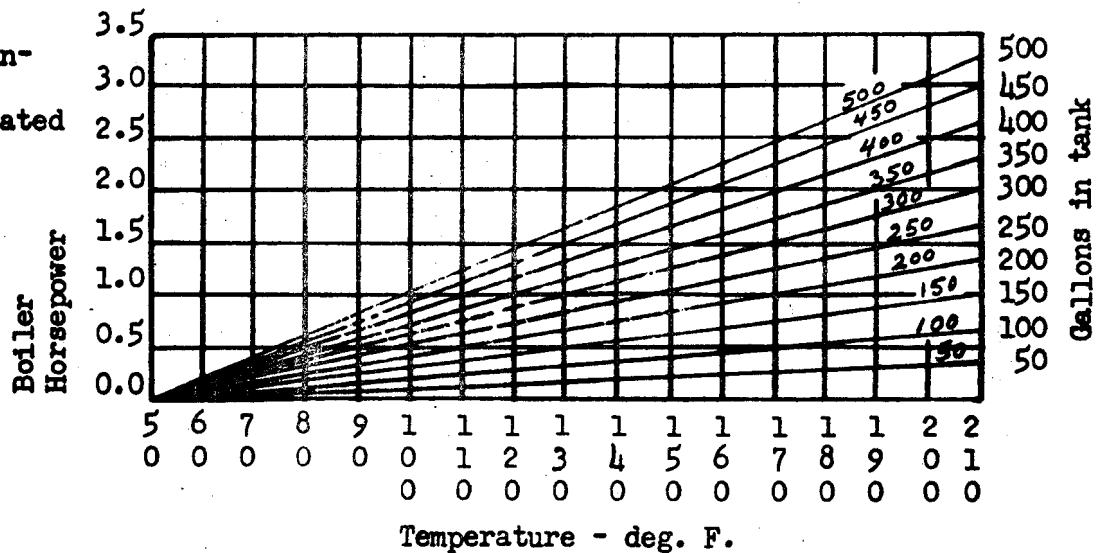
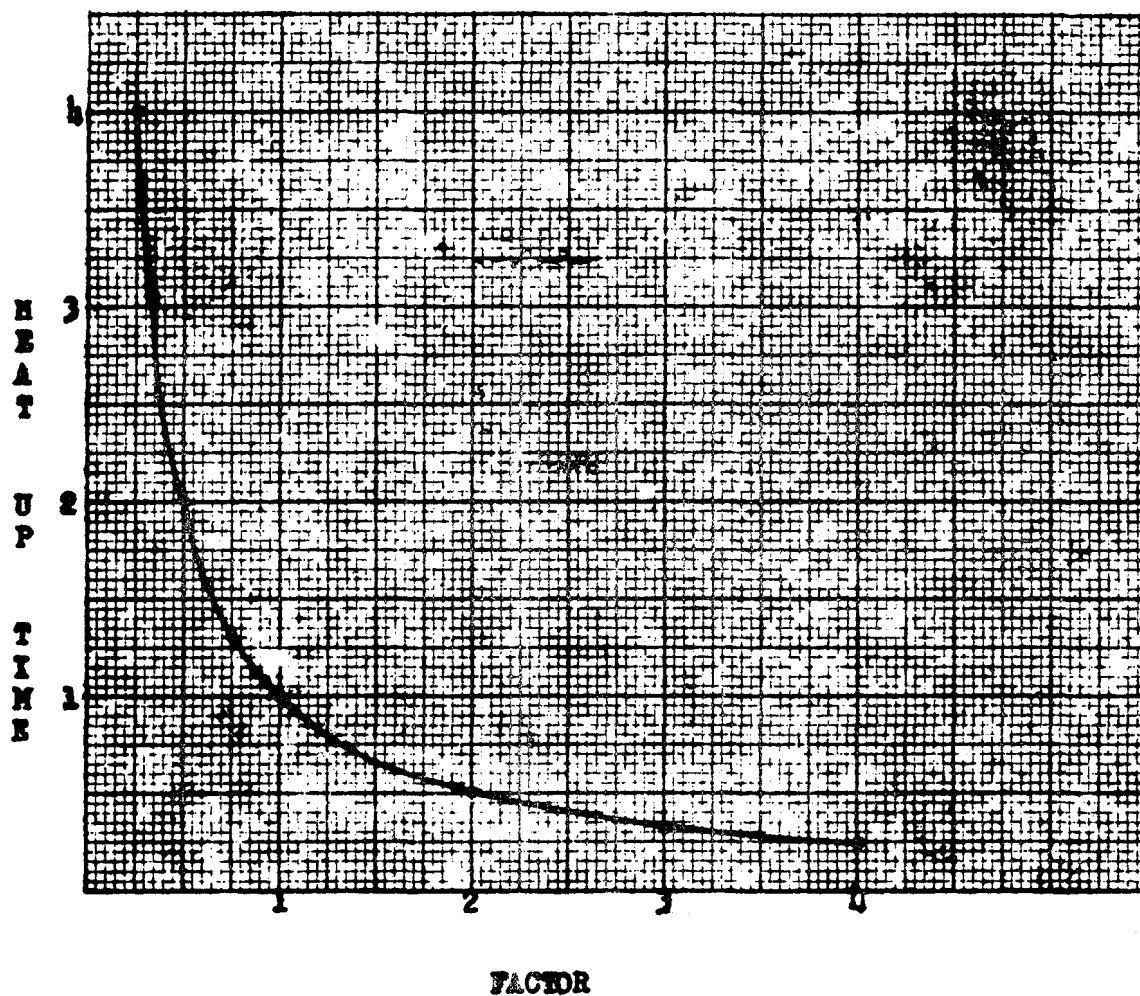


FIGURE C



L A U N D R Y P L A N T S

Laundreis offer an important potential market for packaged steam generators. They require substantial quantities of steam for their washing, drying and finishing processes. The cleanliness and automatic operation of the packaged unit are attractive values for the laundry owner.

Reliable data is available on all types of laundry equipment such that the boiler size for any laundry can be computed accurately. The American Institute of Laundering, Joliet, Illinois, has published an excellent study of laundry needs in their Specail Report 212, "Determination of Laundry Power Plant Requirements". Some of the tables from this report have been reproduced in this section.

Boilers installed in laundries should have minimum allowable working pressure of 125 PSI. The usual case is 105 - 110 PSI. This pressure is necessary in order to provide sufficient temperature for efficient operation of the finishing equipment.

HOT WATER FOR WASHING - The heating water for washing is a major portion of the steam demand in a laundry. The hot water supply is maintained at 180°F. When calculating the amount of steam that must be available for heating water, it is advisable to use the maximum hourly hot water consumption. The Institute has determined that approximately 4½ gallons of hot water are required per pound of clothes washed under average conditions. However, many laundry owners do not keep reliable figures for the pounds of clothing washed. Therefore, it is advisable to add up the total consumption of the washers.

The capacity of a washer is determined by the diameter and length of the wash wheel in inches. The size is usually indicated on a metal tag attached to the side of the washer. If not, the dimensions should be taken with a tapemeasure. Table #7 from the Laundry Institute Report 212 provides reliable estimates of hot water per round consumed by wash wheels of various sizes. The hot water per round can be taken safely as the consumption per hour.

Laundry Plants (cont.)

The following table has been reproduced with permission from the American Institute of Laundering:

<u>Size</u>	<u>Hot Water Per Round</u>	<u>Size</u>	<u>Hot Water Per Round</u>
30 x 30	110 gal.	44 x 108	810 gal.
30 x 36	130	44 x 36	300
30 x 48	190	44 x 54	450
36 x 36	300	44 x 60	495
36 x 48	270	44 x 72	595
36 x 54	300	44 x 84	695
36 x 64	350	44 x 96	790
42 x 36	270	44 x 108	900
42 x 54	405	44 x 120	990
42 x 64	475	54 x 84	870
42 x 72	540	54 x 96	990
42 x 84	630	54 x 108	1110
42 x 96	720	54 x 120	1230

The sum of the individual capacities of the washers will give the maximum gallons of hot water required per hour. In actual practice, a wash round can be completed in less than one hour. However, allowing for loading and unloading the wheels, starching, and the use of low temperature water on certain rounds, the above estimate is reasonable.

To compute the amount of boiler capacity necessary, use the method provided in the Section for "Hot Water Heating". In determining the temperature rise, the temperature of the water supply should be checked carefully. The temperature will vary as between winter and summer, depending on the geographical location and the depth of the supply main. The lowest yearly temperature should be used to provide for the maximum condition.

Some laundries are equipped with reclaimers to preheat the incoming water and reduce the temperature differential. The reclaimer is a heat exchanger which makes use of the waste water from the washers to preheat the water supply from the main.

Another factor that will influence the amount of boiler capacity required is the use of a hot water storage tank. Assuming a storage tank with capacity equivalent to 1/5 the maximum hourly demand of the washers, the amount of boiler capacity needed shall also equal the maximum hourly demand. With a larger tank the capacity can be reduced proportionately. See section on Hot Water for determining the size of storage tanks.

Laundry Plants (cont.)

Hot Water Consumption of Bendix Washers

9# of laundry/load
 30-50 minute cycle
 25 gals. of 140°F water/cycle
 Rating 38 gals. 140°F water/hour/machine

DRYING EQUIPMENT - Since most garments are pressed in a damp condition the "Extractor" plays the biggest part in the drying operation of a laundry. The extractor removes excess moisture from clothing by centrifugal action and does not require any steam. However, tumblers are used for some of the delicate garments and for fabrics that must be dry before finishing. The tumbler consists of a cylinder with perforated outer wall, mounted inside a cabinet. The cylinder is rotated while warm air circulates through the cabinet. The size is determined by the dimensions of the cylinder. The following ratings are furnished for the more popular sizes from Special Report 212 of the American Institute of Laundering.

BOILER HORSEPOWER OF TUMBLERS

<u>SIDE LOADING</u>		<u>OPEN END</u>	
<u>Size</u>	<u>BHP</u>	<u>Size</u>	<u>BHP</u>
30 x 42	2.5		
36 x 48	6.0	26 x 24 (Twin)	3.5
40 x 44	5.8	36 x 18	3.2
40 x 64	8.2	36 x 24	3.7
40 x 94	12.0	36 x 30	3.9
42 x 40	6.0	42 x 42	7.2
42 x 42	7.5	44 x 42	8.0
42 x 60	11.0		
42 x 90	16.0		
42 x 120	22.0		
46 x 120	19.0		

Drying rooms or cabinets are used for drying curtains, blankets, and bedspreads. These are usually heated by radiators or pipe coils. The radiation load should be computed as for heating. These cabinets are not in frequent use and usually do not affect the maximum load.

Laundry Plants (cont.)

FLATWORK IRONERS - These large pressing units were formerly described by the term "Mangle". They are used for pressing tablecloths, sheets, napkins and other linens. These machines have a large output when properly operated with sufficient temperature. The large cylinder type rolls have been replaced to a large extent by the small diameter, multiple roll machines. Ratings from the Laundry Institute Report #212 are reproduced below:

BOILER HORSEPOWER RATINGS OF STEAM HEATED FLATWORK IRONERS

<u>Chest Type</u>	<u>Size</u>	<u>BHP</u>	<u>Chest Type</u>	<u>Size</u>	<u>BHP</u>
1 Roll	54	1.2	8 Roll	100	22.0
	66	1.5		120	22.0
	100	2.0	12 Roll	120	33.0
2 Roll	100	4.0			
	110	4.0	1 Cylinder	16 x 75	3.0
	120	4.0		16 x 110	3.29
4 Roll	100	9.0		24 x 100	7.0
	110	9.0		30 x 100	10.0
	120	9.0		48 x 100	11.0
6 Roll	100	13.0	2 Cylinder	30 x 100	12.5
	110	13.0		30 x 120	15.0
	120	13.0		36 x 120	20.0

PRESSES - Pressing machines used in laundries can be divided into two classes, shirt presses and apparel presses. During production basis. Groups of presses for finishing cuffs, collar, yoke, sleeves, and bosom have been assembled in units and designated as "two-girl" and "four-girl" units, depending on the number of employees working as teams. The rating for a "two-girl" unit is 5.5 BHP. The rating for a "four-girl" unit is 10.0 BHP.

The ratings for presses of various sizes, as furnished by the American Institute of Laundering in Special Report #212 as shown on the following page.

Laundry Plants (cont.)

RATED BOILER HORSEPOWER OF SHIRT PRESSES

<u>Type of Press</u>	<u>BHP</u>
Cuffs	0.75
Collar and Cuffs	0.75
Cuffs and Gussets	0.75
Yoke	0.27
Single Sleeve Press	0.27
Double Sleeve Press	1.1
Double Sleeve Form	0.5
Cabinet Sleeve Press	1.1
Collar	0.3
Body	1.5
Bosom	1.5
Rotary Bosam	1.5
Rotary Bosom and Body	3.2
Cabinet Bosom and Body	1.54

RATED BOILER HORSEPOWER OF PRESSES

<u>Size</u>	<u>BHP</u>	<u>Size</u>	<u>BHP</u>
Pony	0.37	40"	1.0
25"	0.40	42"	1.1
27"	0.45	50"	1.5
31"	0.70	51"	1.5
36"	0.72	52"	1.5
37"	0.80	54"	1.9
38"	0.80		

BOILER HORSEPOWER FOR CURTAIN & BLANKET DRYERS

<u>Type and Size</u>	<u>BHP</u>	<u>Type and Size</u>	<u>BHP</u>
Horizontal			
48" x 108"	1.0	2 - draw	2.5
54" x 120"	1.3	3 - draw	5.7
54" x 180" (1)	2.0	4 - draw	10.0

MISCELLANEOUS

Hankerchief Press	1.5 BHP
Hosiery Form	.5
Starch Cooker (15 gal.)	.5

P R O C E S S H E A T I N G

There are many variations to the application of heat by steam in processing industries. In some types of operations specific data has been derived from observation and study, such as in the laundry, bottling and dairy industries. In other operations, the determination of boiler output required must be accomplished by basic heat and steam formulas.

This section deals with the basic approach to measurement of steam requirements:

In process heating, the following factors must be considered

1. Heat required to raise temperature of substance
2. Heat required to raise temperature of heating vessel
3. Heat required to overcome radiation losses.

The greatest amount of heat is consumed in raising the temperature of the substance and the heating vessel to the operating temperature of the process. This is the maximum load which must be provided by the boiler. Maintenance of operating temperature merely requires replacement of losses due to radiation, convection, and conduction. The maximum load then is the amount of heat added to the substance and heating vessel in raising the temperature.

The total heat required can be obtained by the following formula:

$$H = (WS + ws) T$$

- W - Weight of substance (lb)
- w - Weight of heating vessel (lb)
- S - Specific heat of substance
- s - Specific heat of metal of vessel
- T - Temperature rise (°F)
- H - Heat required (BTU)

The output of steam generators is measured in lb. of steam/hour from and at 212°F. In actual practice, boiler operation at 0 lbs. pressure from feedwater at 212°F is an uncommon condition. Therefore, in measuring the boiler output required to supply heat for a process, allowance must be made for the actual boiler working pressure and the temperature of the feedwater.

Process Heating (cont.)

The steam required at operating pressure can be found by dividing the total heat, as computed above, by the enthalpy of evaporation (see STEAM TABLE) for that pressure:

$$\begin{array}{l} \text{Lb. of steam/hr.} \\ \text{at working pressure} \end{array} = \frac{\text{Heat Required (BTU)}}{\text{Heating Time (hrs) x Enthalpy of Evap. (BTU/lb.)}}$$

The lbs. of steam per hr. figure obtained must then be converted to equivalent steam output from and at 212°F. as follows:

- W - total steam requirements at operating conditions (#/hr)
- T - temperature of feedwater (°F)
- S - T-32 = enthalpy of feedwater (BTU/#)
- P - enthalpy of saturated vapor at oper. pressure (BTU/#)
- H - P-S - heat required to evaporate 1# water at feedwater temperature into steam at operating pressure (BTU/#)

$$\text{Equivalent \#/hr. from and at 212°F} = \frac{HW}{970.2}$$

$$\text{Equivalent BHP} = \frac{HW}{33475}$$

STEAM TABLE

<u>P S I</u> <u>Gauge</u>	<u>Enthalpy</u> <u>Evap.</u>	<u>Enthalpy</u> <u>Sat.</u> <u>Vapor</u>	<u>P S I</u> <u>Gauge</u>	<u>Enthalpy</u> <u>Evap.</u>	<u>Enthalpy</u> <u>Sat.</u> <u>Vapor</u>
0	970.3	1150.4	80	891.7	1186.2
10	952.6	1160.2	90	885.9	1188.0
20	939.5	1167.2	100	880.7	1189.6
30	928.9	1172.0	110	875.5	1191.0
40	919.7	1176.2	120	870.6	1192.6
50	911.0	1179.1	130	865.9	1193.5
60	904.6	1181.9	140	861.4	1194.6
70	898.0	1184.2	150	857.1	1195.6

STEAM ATMOSPHERE HEAT TREATING

According to reports of manufacturers of this equipment, many plants have found steam atmosphere heat treating a successful as well as inexpensive answer to their quality-improvement search.

The following tabulation of steam requirement has been supplied by Leeds & Northrup for their Homo Method equipment. Steam is supplied at 5#/sq.in.

<u>Furnace Number</u>	<u>Work Space</u>		<u>Steam Required # Hr.</u>	<u>BHP</u>
	<u>Dia.</u>	<u>Depth</u>		
9512-15	11.5	15.0	10	0.291
9514-16	14.0	16.0	20	0.582
9519-14	19.0	14.0	30	0.873
9525-19	25.0	19.0	55	1.600
9522-26	22.0	26.0	50	1.457
9522-36	22.0	36.0	60	1.750
9522-48	22.0	48.0	70	2.040
9522-60	22.0	60.0	85	2.475
9528-28	28.0	28.0	75	2.180
9528-36	28.0	36.0	85	2.475
8528-48	28.0	48.0	110	3.200
9528-60	28.0	60.0	130	3.785
9540-36	39.0	36.0	160	4.660
9540-48	39.0	48.0	190	5.530
9540-60	39.0	60.0	220	6.400
9540-72	9.0	72.0	250	7.280
9550-48	50.0	48.0	280	8.150
9550-60	50.0	60.0	320	9.320
9550-72	50.0	72.0	360	10.500

ESTIMATING STEAM REQUIREMENTS

The output capacity of a steam generator is rated in pounds of steam per hour from and at 212°F.

34.5 pounds of steam/hr from and at 212°F is defined as equal to 1 boiler horsepower.

According to this definition 1 boiler horsepower also equals 33 475 BTU per hour from and at 212°F.

Est. Steam Requirements (cont.)

A popular method of calculating the boiler horsepower needed for hot water making is to divide the total BTU required by 33,475.

Example: A building requires 400 gal. of hot water/hr at 180°F. The temperature of the supply water is 60°F. How many boiler horsepower will be required?

Quick Solution.
$$\frac{400 \text{ gal} \times 8.34 \# \text{ water/gal} \times (180^\circ - 60^\circ)}{33,475 \text{ BTU/BHP}} = 11.96 \text{ BHP}$$

However, the method outlined above is subject to considerable error, because it assumes that the boiler is to be operated with feedwater at 212°F. and at 0 lbs. pressure. Actually, feedwater temperatures may vary from 50°F to 200°F and operating pressures from 2 to 150#/sq.in.

Therefore, when water heating represents a major part of the total boiler load, or when precise measurement is otherwise required, the following method of calculation, with use of steam tables, is recommended.

A) Calculate total BTU required:

No. gal. x 8.34# water/gal x temperature rise (°F.)

B) Select the enthalpy of evaporation at gauge pressure. Use steam table.

C) Calculate steam demand in lb. steam/hr. steam/hr at gauge pressures:

A) divide by B).

D) Select from steam table:

a) Enthalpy of saturated vapor at gauge pressure

b) Enthalpy of saturated liquid at boiler feed temperature.

E) Calculate the equivalent steam demand in lbs. of steam/hr from and at 212°F.

$$\frac{E \times C}{970.3}$$

(the enthalpy of evaporation from and at 212°F. = 970.3 BTU/hr.

Est. Steam Requirements (cont.)

- G) Calculate the equivalent boiler horsepower:
F) divided by 34.5

Example: Let us use the preceding example (where a building requires 400 gal. of 180°F hot water/hour, with supply temperature of water 60°F. Figure that the boiler's feedwater temperature is 180°F. and figure that the boiler operates at 100#/sq.in. gauge pressure.

Correct solution:

Solution

A) $400 \times 8.34 \times 120 = 400,320 \text{ BTU} = \text{total heat required.}$

B) Enthalpy of Evap. at 100 PSI (gauge) = 880.1 BTU/#

C) $400,320 + 880.1 = 454.9\# \text{ steam/hour}$

D) a) Enthalpy of sat. vapor at 100 PSI = 1189

b) liquid at 180°F. = $\frac{148}{1041}$

E)

F) Equivalent steam demand from and at 212°F.

$$\frac{1041 \times 454.9}{970.3} = 488.1\# \text{ steam/hour}$$

G) Equivalent boiler horsepower from and at 212°F.

$$488.1 + 34.5 = 14.12 \text{ BHP/hour}$$